DOCUMENT RESUME

ED 192 594 FL 011 799

AUTHOR Kayra-Stuart, Fortunee
TITLE On Acquisition of Temporal Concepts and Temporal Words. Papers and Reports on Child Language Development, Number 18.
INSTITUTION Stanford Univ., Calif. Dept. of Linguistics.
PUB DATE 80
NOTE 19p.; Based on a doctoral dissertation, Claremont Graduate School. A portion of the paper was presented at the Biennial Meeting of the Society for Research in Child Development (New Orleans, LA, March 1977).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Child Language; Cognitive Development; Language Acquisition; Language Research; Observational Learning; Psycholinguistics; *Time Perspective; *Vocabulary Development; Young Children

ABSTRACT

Forty-five children drawn equally from nursery school, kindergarten, and first grade were administered a nonverbal imitation task, a production task, a comprehension task, and a verbal imitation task. The results of the four tasks support the Temporal Complexity Hypothesis, which states that the components of temporality--order among events (O), simultaneity of events (S), and duration of events (D)--are acquired before their coordinations (OD, SD). Results also supported the order of acquisition hypothesis which predicted the order O, S, D. The order of difficulty of the tasks was found to be nonverbal imitation (easiest), verbal imitation, comprehension, and production. Within-subject analysis of the data supported cross-subject analysis. The following conclusions are drawn: (1) conceptual knowledge generally precedes linguistic knowledge; (2) children were able to imitate words just beyond their comprehension, suggesting that they may learn to use new words through imitation; and (3) children understand temporal words before they are able to describe temporal relationships. (JB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Stanford Dept. of Linguistics
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

ED192594

FL011799

On Acquisition of Temporal Concepts and Temporal Words*

Fortunee Kayra-Stuart

Stanford University

In a study of a concept the completeness of its definition is of critical importance. For this study, I argue that an understanding of temporal relations consists of an understanding of the relationship among order of events (O), simultaneity of events (S), and duration of events (D) (Piaget, 1927). O,S,D are defined as the basic cognitive structures or components that underlie the concept of time. These three components (O,S,D), and their two interrelationships, order + duration (OD) and simultaneity + duration (SD) were studied. The acquisition of nonlinguistic knowledge about a concept is closely related to the acquisition of words describing that concept. I therefore examined the components and their two interrelationships in four tasks: a nonverbal imitation task to examine acquisition of concepts and three verbal tasks (production, comprehension, and imitation) to examine acquisition of words.

Prior work on the acquisition of temporal concepts and temporal words has been fragmentary. Piaget who offered a comprehensive definition for his study of the concept of time did not study temporal words. Subsequent research on the acquisition of temporal words has focused mainly on the components of meaning in different words (O,S,D) but has examined neither the combination of these components (OD,SD) nor children's conceptual knowledge (E. Clark, 1969, 1971; Feagans, 1974; Keller-Cohen, 1974).

In this study two hypotheses were tested. The Temporal Complexity Hypothesis predicts that for conceptual knowledge each component (O,S,D) is acquired separately before it is combined with any other component (OD,SD) (H. Clark, 1973). In a similar manner, these components are attached to words one at a time, and words with one component (O,S,D) are acquired before words with a combination of components (OD,SD) (Semantic Feature Hypothesis, E. Clark, 1973). The hypothesis predicts that both on the nonverbal and verbal tasks some children would succeed on all the components but fail the coordinations and that if children succeed on OD or SD they would also succeed on at least the components involved in that coordination. In contradiction to this hypothesis, Piaget argued that O,S,D are not understood until they are coordinated with each other (OD,SD). Piaget's position would be supported

---

*This study is based on a doctoral dissertation submitted to the Claremont Graduate School. A portion of this paper was presented at the Biennial Meeting of the Society for Research in Child Development in New Orleans, March 1977. I wish to thank Dale Berger and Leah Light for their helpful suggestions during the course of the study, and Eve Clark for reading an earlier draft of this paper. I am also grateful to the staff and children of Pacific Oaks College and Children's School, Pasadena, California; Child Development Center for Caltech Families, Pasadena, California; and Wilson School, San Gabriel District, Arcadia, California for making the project an enjoyable experience.

if children who succeed on O,S and D also succeed on OD,SD and if children who fail OD,SD also fail O,S and D.

The O,S,D Hypothesis, the second hypothesis predicts that the concept of order is acquired first, then simultaneity and finally duration. This same order is also predicted for the acquisition of temporal words. Order relations may be easier to master than simultaneity because children tend to attend to events one at a time (Ferreiro, 1971; Piaget, 1971). Duration relations may be the hardest of the three because it requires a more abstract discrimination of time.

Both hypotheses make the same predictions for the acquisition of temporal concepts examined in the Nonverbal Imitation task, and the acquisition of temporal words examined in the three verbal tasks. Each component is acquired separately in the order O,S,D before it is combined with any other component. In addition, it is predicted that conceptual knowledge of both the individual components and their coordinations precedes knowledge of the words referring to them.

Method

Subjects

Fifteen nursery school children, 15 kindergarteners, 15 first graders, and seven adults (graduate students) were tested. The mean ages of the three groups were 4;3, 5;8, and 6;11. All children were native speakers of English and were selected from schools in a middle class neighborhood. The kindergarten and first graders attended a public school and the nursery school children a private nursery school.

Procedure

Each child and adult was given four tasks in the same order; 1) a Nonverbal Imitation task in which they imitated the actions performed by the experimenter; 2) a Production task in which they described what the experimenter had acted out; 3) a Comprehension task in which they acted out commands read to them and answered questions about the temporal relations of events in stories; and 4) a Verbal Imitation task in which they repeated sentences read to them. The Production task preceded the Comprehension and the Verbal Imitation tasks not to influence the children by the experimenter's use of temporal words. Each task included trials for the three components (O,S,D) and their coordinations (OD,SD). The trials in each task were randomized for each child by a computer program. The experimental design was a three factor design with 15 subjects at each of the three age levels and repeated measures on task and trial types.

Each child was examined individually for five sessions of 10-15 minutes each. The Production, the Verbal Imitation tasks and the Stories subtask of the Comprehension task were tape recorded. Two independent observers scored six of the children to establish reliability for scoring. The agreement between the two observers was 98%.

Materials

Three behavioral modes were included in the tasks, body movements,

manipulation of lights, and language. Table 1 shows the input by the experimenter and the output requested from the children for each task. The tasks will be described in detail later. For body movements simple actions that could be easily performed by 4-year-olds were used, such as "pinch cheek", "raise arm". For the manipulation of lights, a cardboard box with one red and one green light mounted along the top edge was used. The lights could be turned on by pushing a red or a green telegraph key at the bottom of the box each immediately below its respective light. In the Comprehension and Verbal Imitation tasks order was tested with before, after, first, last; simultaneity with at the same time, when; duration with a long time, a short time; order + duration with until; simultaneity + duration with while, during. For the Stories subtask in the Comprehension task, five frames for each of the stories were drawn in color on 12.7 X 10.2 cards.

Table 1

Tasks Categorized by the Experimenter's Input and the Child's Output

Input (E)	Output (C)		
	Body Movements	Lights	Language
Body Movements	Nonverbal Imitation	---	Production
Lights	---	Nonverbal Imitation	Production
Language	Comprehension	Comprehension	(1)Verbal Imitation (2)Comprehension

The trials for all four tasks involved one actor and two actions for all the components and their coordinations except duration which involved one actor and one action. For example, in the Verbal Imitation task, for order the children were asked to repeat "The girl watches the lions before she runs," and for duration, "The girl runs in the park for a long time." Countable, discrete body movements like pat, tap, rub, slap were not used since with the trials involving duration, a judgment might be reached by counting the discrete parts of the actions.

Tasks

Nonverbal Imitation. The input by the experimenter was either body movements or manipulation of lights involving O,S,D,OD,SD, and the requested

output was the child's imitation of the same. For example, for O, the experimenter pushed the red button, then the green button; for S she pushed the red and the green at the same time; for D, she pushed the red for a long time; for OD she pushed the red for a long time then pushed the green for a short time; for SD, she pushed the red and the green at the same time for a long time. The instructions were. "Watch me carefully, wait until I finish and do what I do." There were 8 trials for each concept, 40 trials altogether.

When using body movements as input, the experimenter's initial and final positions for each trial were always the same, standing straight with her hands down. For O and OD, she performed one action, put her arms down to the initial position, then performed the second action. For S and SD, she performed both actions at the same time, then put her arms down to the initial position. When using manipulation of lights as input she followed the same rules.

For D, OD, SD short duration was defined as 4 seconds and long duration as 8 seconds. For the coordinations, short and long durations were combined in all possible ways. For O and S the actions lasted only very briefly and were assumed to be of no duration. According to Fraisse (1963) a duration of less than 3 seconds is not perceived as duration.

Production. For this task, the input by the experimenter was identical to the input for the Nonverbal Imitation task, and the children described what the experimenter had acted out. The instructions were "Tell me what I did." It was expected that the children would use temporal words in describing the actions, e.g., before, after, or at least describe the components or coordinations.

Comprehension. For this task, the input was language and the output was either Body Movements, Manipulation of Lights or language (Stories). For the Body Movements and Manipulation of Lights subtasks, the children acted out commands read to them. The instructions were "Do what I tell you." The commands included the temporal words describing O,S,D,OD,SD, e.g., "Push the red before you push the green."

Young children often rely on an order of mention strategy in comprehension experiments (E. Clark, 1971). The order of mention strategy predicts that it is easier to describe or interpret events mentioned in order of occurrence than in the order opposite of their occurrence. To isolate the effects of order of mention in interpreting the order of events, for before, after, first, last, and until, trials where the order of mention was the same as the order of events (OM+) were counterbalanced with trials where the order of mention was the opposite of the order of events (OM-). For example, "Push the red before you push the green" and "Before you push the green push the red."

In each subtask there were 4 trials (2 OM+, 2 OM-) for each of the temporal words, before, after, first, last, and until. First and last appeared together in one sentence, e.g., "Push the red first and push the green last." The other words when, at the same time, a long time, a short time, while, during each had 2 trials per subtask. The total number of trials per subtask was 28.

The Stories subtask required the children to answer questions about the temporal relations between events in stories. There were five frames of

pictures for each of four sequences of events. The four stories were about a girl at a zoo, a girl at school, a boy at a park, and a boy at a beach. The five frames were placed one at a time from left to right in front of the child. The frames for each story were put in the same order for all the children. As the experimenter put each frame down, she described the action or actions in the frame and asked the child, "What does the girl (boy) do here?" When all five frames were down in front of the child, the experimenter said, "See the story starts here (points to the leftmost frame), goes on and ends here (points to the last frome on the right)" to make sure the children understood that the story progressed from left to right. Then a question was asked with each temporal word, e.g. "What does the girl do before she watches the lions?." Each of the stories had 11 questions, one for each temporal word, and they were presented sequentially in random order for each child. The verbs used with when, and at the same time which described S relations were momentary verbs, i.e., they indicated an action that happened and ended immediately, e.g., drop, throw, touch, pick. The verbs for while and during which described SD relations had a durative aspect, e.g., slide, swing, build, swim.

For D, short duration was defined as an action that happened in one frame only and a long duration an action that occurred in two frames in succession.

Verbal Imitation. Children repeated sentences which included temporal words for O,S,D,OD,SD which were read to them. The effects of the order of mention were also examined as in the Comprehension task. There were 8 trials (4 OM+, 4 OM-) for before, after, first, last, and until. First and last appeared together in one sentence, e.g. "The girl slides first, she swims last." There were 4 trials for each of the other temporal words, when, at the same time, a long time, a short time, while, and during. The sentence length was approximately the same for O,S,D,OD,SD. The present tense was used for all components and coordinations.

Scoring

Performance on each trial was scored correct with a score of one (1) or incorrect with a score of zero (0).

On the Nonverbal Imitation task, a response was scored correct only if the children reproduced the experimenter's actions and their temporal relations correctly. An imitation of a short duration was scored correct if it was 4 seconds or shorter, and of a long duration if it was 8 seconds or longer. There were no problems in judging whether the children's actions were of long, short, or very short duration. The long durations most of the time exceeded 8 seconds, the short durations were about 2-3 seconds, and the very short durations were extremely short. For imitations involving order relations to be scored correct, the children had to return to the initial position with their arms down after imitating the first action and then imitate the second action.

On the Production task any correct description of temporal relations performed by the experimenter was scored as correct. On the Body Movements and Manipulation of Lights subtasks of the Comprehension task, the same criteria as on the nonverbal Imitation task were used. For the Stories subtask, for the questions with before any frame preceding the one pointed to by the experimenter was scored as correct.

For the Verbal Imitation task, the verbs, the order of the verbs and the temporal words had to be repeated correctly. As the actions involved only one actor, the subject of the sentence could be switched from girl to boy or vice versa. As the S sentences contained the same verb twice (e.g., the girl touches the deer and she touches the zebra at the same time), a repetition with only one verb (e.g., the girl touches the deer and the zebra at the same time) was scored correct. However, most of the time children included two verbs in their repetitions.

For examining the order of acquisition of the components and coordinations, in the Comprehension and Verbal Imitations tasks, I collapsed the scores for before, after, first and last for order, at the same time and when for simultaneity, a long time and a short time for duration, until for coordination of order + duration, while and during for the coordination of simultaneity + duration.

Data analysis

The data were analyzed in terms of percentage of correct responses, frequency and types of errors, intertask correlations and correlations among the three components and their coordinations.[1] Both across-subjects and within-subject analyses of the data were carried out. Finn's Multivariate Program, Version IV (1974) was used to compute a multivariate analysis for the across-subjects analysis. Since the total percentage correct for the Production task was extremely low (9%), this task was excluded from the multivariate analysis and examined separately. For the within-subject analysis, for each child success or failure for the components and their coordinations on each task was determined. A division point separating success and failure was selected for each task. The division point for each task was close to its overall average and it was the same for the three age groups and all the components and coordinations with that task.

Results

The results support the Temporal Complexity Hypothesis, and the O,S,D Hypothesis. They also show a consistent order of task difficulty with the Nonverbal Imitation task being the easiest followed by the Verbal Imitation, the Comprehension, and the Production task in that order.

For the adults tested percentage correct on the Nonverbal Imitation, Verbal Imitation, and Comprehension tasks was 100; percentage correct on the Production task was 98.5.

Temporal Complexity Hypothesis

The results of the four tasks support the Temporal Complexity Hypothesis

---

[1] A matrix of the correlations among the concepts and the correlations among the four tasks was constructed to examine the validity of the concepts (O,S,D,OD,SD) across the four tasks, i.e., to examine how the measurements of the same concept in the four different tasks are related to each other (convergent validity) and how the concepts are differentiated from each other (discriminant validity) (Kayra-Stuart, 1978).

which states that the components (O,S,D) are acquired before their coordinations (OD,SD). The data come from two sources: across-subjects, and within-subject analyses.

Table 2

Mean Percentage of Correct Responses for Each Component and Each Coordination in Each Task as a Function of Age

Tasks	Ages	Components			Coordinations		Means
		O	S	D	SD	OD	
Nonverbal Imitation	4;3	88	90	79	42	47	69
	5;8	98	96	93	65	72	85
	6;11	100	100	99	86	93	96
Means		95	95	90	64	71	83
Verbal Imitation	4;3	77	70	86	58	27	64
	5;8	90	74	94	69	48	75
	6;11	95	90	100	80	82	89
Means		87	78	93	69	52	75
Comprehension	4;3	74	73	72	58	24	60
	5;8	86	84	85	67	24	69
	6;11	95	98	94	91	24	81
Means		85	85	84	72	24	70
Production	4;3	20	9	5	3	4	8
	5;8	15	13	4	3	2	7
	6;11	22	16	13	5	8	13
Means		19	13	7	4	5	9

Across-subjects analysis. Table 2 shows the mean percentage of correct responses for each component and coordination in each task by age.

The multivariate analysis of the Nonverbal Imitation, Verbal Imitation, and Comprehension tasks shows that in all three tasks percentages correct for the components were higher than percentages correct for the coordinations. The O,S,D vs OD,SD; the O,D vs OD; and the S,D vs SD comparisons over all the three tasks were highly significant, $F(4,39)=297.8$, $p<.001$, $F(4,39)=121.6$, $p<.001$, $F(4,39)=322.5$, $p<.001$ respectively. These three comparisons were

highly significant for each of the four tasks separately. The interaction between age and concept was significant for the Nonverbal Imitation task only, $F(8,78)=3.5$, $p<.001$. This interaction was probably due to the better performance of the 6-year-olds on the coordinations (Table 2). In the multivariate analysis, the significant interaction between concept and task for the O,S,D vs OD,SD comparison ($F(8,35)=019$, $p<.001$) was probably due to the very low percentage correct on OD in the Comprehension task (Table 2).

Across-subjects analysis of the temporal terms. Table 3 shows percentage of correct responses for each term in each task by age. The order of difficulty of the individual temporal terms in the Verbal Imitation and Comprehension tasks is consistent with the Temporal Complexity Hypothesis which predicts that words with one component are acquired before words with two components. The percentages of correct responses for the words describing O,S,D are higher than those describing OD,SD except for when. When defined as referring to S in this study was as difficult as while referring to SD. The reason might be that when is difficult to interpret because it may refer to O or S (Clancy, Jacobsen & Silva, 1976).

Table 3

Percentage of Correct Responses for each Temporal Term in each Task by Age

Concept	Temporal Term	Tasks: Verbal Imitation				Comprehension				Overall Mean
	Age	4;3	5;8	6;11	Mean	4;3	5;8	6;11	Mean	
O	Before	77	89	99	88	73	83	93	83	86
	After	80	96	98	91	71	74	94	80	86
	First	78	86	90	85	79	99	98	92	88
	Last	73	86	88	82	79	98	98	92	87
S	At the same time	73	92	100	88	79	91	100	90	89
	When	67	57	80	68	66	78	98	81	74
D	A long time	83	92	100	92	78	84	100	87	90
	A short time	87	95	100	94	66	84	87	79	87
SD	While	55	70	78	68	71	78	94	81	74
	During	60	67	82	70	48	56	88	64	67
OD	Until	27	48	82	52	24	24	24	24	38
	Mean	69	80	91		67	77	89		

Table 4

Frequency of Temporal Terms in Adult Spoken English and Percentage of Correct Child Responses for the Terms in the Verbal Imitation and Comprehension Tasks

Term	Frequency	Percentage Correct Verbal Imitation	Comprehension
When	954	68	81
First	279	85	92
After	258	91	80
Before	209	88	83
Last	207	82	92
While	146	68	81
Until	137	52	24
During	57	70	64

[a]From Howes, 1966.

The componential analysis of the temporal terms predict the order of difficulty of these terms observed in previous studies (Barrie-Blackley, 1973; Feagans, 1974; Keller-Cohen, 1974). The frequency of the terms in adult English does not explain their order of difficulty for either task (Table 4, rank order correlations are not significant). Furthermore, syntactic differences do not explain the order of difficulty among the temporal terms. Although the length of the sentences were approximately the same, some sentences included one verb (sentences with a long time, a short time, during) some sentences included the same verb twice (sentences with at the same time), and other sentences included two verbs (sentences with first, last, before, after, when, until, while). The number of verbs does not seem to account for the order of difficulty of the temporal terms, e.g., during sentences with one verb are significantly harder than before sentences with two verbs. Secondly, some temporal words were used as adverbs (a long time, a short time, at the same time, first, last) some as prepositions (during) and others as subordinating conjunctions (before, after, when, while, until). E. Clark (1969) observed that children used before and after first as prepositions and later as subordinating conjunctions. In the present study, the syntactic distinction between prepositions and subordinating conjunctions does not account for the order of difficulty among the temporal terms, e.g., during

a preposition was significantly harder than before a subordinating conjunction (Table 3).

The results of the Comprehension task supported the order of mention strategy. It predicts that it is easier to describe or interpret events in the order of their occurrence (OM+) rather than in the order opposite of their occurrence (OM-). Percentage correct for OM+ was significantly higher than percentage correct for OM-, $t(44)=4.9$, $p<.001$. The order of mention strategy was significant for each age group. In the Verbal Imitation task, the difference between OM+ and OM- was not significant.

Within-subject analysis. For the within-subject analysis the pattern of acquisition of the components and their coordinations was determined for each child separately.

For the Nonverbal Imitation task the results of all 45 children are dramatically consistent with the Temporal Complexity Hypothesis, i.e., there were no children who succeeded on the coordinations yet failed the respective components ($\chi^2_{(1)}=17.7$, $p<.001$). For the Verbal Imitation task the results of 42 children are consistent with the hypothesis ($\chi^2_{(1)}=13.5$, $p<.001$). For the Comprehension task the results of 41 children are consistent with the hypothesis ($\chi^2_{(1)}=12.2$, $p<.001$). For the Production task the results of 38 children are consistent with the hypothesis ($\chi^2_{(1)}=8.7$, $p<.001$). The results of 3 children in the Comprehension task, 4 in the Verbal Imitation task, and 7 children in the Production task contradicted the hypothesis.

The number of children from each age group falling within each acquisition pattern shows a developmental trend which also supports the Temporal Complexity Hypothesis. For the Nonverbal Imitation, the Verbal Imitation and the Comprehension tasks, most of the children in the two younger groups succeeded on the components but only a few succeeded on the coordinations. In contrast, most of the oldest group succeeded on both.

Order of acquisition of the components: the O,S,D Hypothesis

It was expected that children would acquire O first, then S and finally D. The results of the Nonverbal Imitation, Comprehension, and Production tasks were consistent with the O,S,D Hypothesis (Table 2). Only some of the comparisons were significant. In the Nonverbal Imitation task, O was significantly easier than D, $F(4,39)=7.2$, $p<.01$. In the Production task O was significantly easier than D, $F(4,39)=8.0$, $p<.001$. In the Comprehension task none of the differences were significant. But, in the Verbal Imitation task, the finding that D was significantly easier than O($F(4,39)=17.9$, $p<.001$), and S($F(4,39)=32.5$, $p<.001$) contradicts the O,S,D Hypothesis which predicts duration should be the hardest. However, an analysis of errors revealed substitutions in all four tasks which strongly support the O,S,D Hypothesis.

Substitution errors. I will present an example of substitution errors in each task before discussing the results. A substitution error in the Nonverbal Imitation would occur if the experimenter pushed the red and the green lights at the same time and the child responded by pushing the red and then the green light. A corresponding error in the Comprehension task would occur if the experimenter said, "Push the red and push the green at the same time," and the child pushed the red then the green. These are O substitutions for S trials. A substitution error in the Verbal Imitation task would occur

if the experimenter said, "The boy swings until he buys a balloon," and the child responded with "The boy swings after he buys a balloon." A corresponding error in the Production task would occur if the experimenter pushed the red for a long time and then pushed the green for a short time, and the child's response was only "You pushed the red then the green." The last two examples represent O substitutions for OD trials.

Table 5

Number of Substitution Errors of the Components and Coordinations for all ages and Tasks

Input by E	Error Output					
	O	S	D	SD	OD	Total
O	---	12	1	0	3	16
S	124	---	4	8	0	136
D	27	1	---	0	0	28
SD	208	83	39	---	10	340
OD	335	93	42	2	---	472
Total	694	189	86	10	13	992

Out of a total of 2495 errors, 992 were substitution errors. Table 5 shows the total number of substitution errors over all the ages and over all the tasks. Substitution of O responses for S,D,OD,SD accounted for 694 out of a total of 992 errors. This was followed by S substitutions with 189, and D substitutions with 86, followed by 23 coordinations substitutions. This trend is apparent for each task separately.

The above findings suggest that children know O best and give O responses when other temporal relations are not understood. S relations are known less well than O relations and D relations are the least known since they are seldom given as descriptions of other temporal relations. Similarly O words (before, after, first, last) are known best, then S words (at the same time, when), and finally D words (a long time, a short time).

Order of Difficulty of the Tasks

The across-subjects and within-subject analysis of the results support the following order of difficulty of the tasks: Nonverbal Imitation, Verbal Imitation, Comprehension, and Production.

Across-subjects analysis. The multivariate F for this overall task effect was highly significant, $F(3,40)=638.3$, $p<.001$, when the Production task was included in the analysis. The overall task effect without the Production task was still significant, $F(2,41)=42.1$, $p<.001$. In this analysis the Nonverbal Imitation task was significantly easier than the Verbal Imitation task, $F(1,42)=15.6$, $p<.001$, and the Comprehension task, $F(1,42)=86.0$, $p<.001$. The Verbal Imitation task was also easier than the Comprehension task, $F(1,42)=9.6$, $p<.01$.

The interaction between age and task was not signigicant, but the interaction between concept and task was significant, $F(8,35)=29.1$, $p<.001$. The concept and task interaction was probably due to OD for which the differences among the tasks was greater than for O,S,D, and SD and also to S for which precentage correct in the Comprehension task was higher than percentage correct in the Verbal Imitation task (Table 2). This latter is inconsistent with the overall order of difficulty of the tasks.

Within-subject analysis. This analysis showed the same order of difficulty of the tasks. Table 6 shows the various patterns of difficulty of the Nonverbal Imitation, Verbal Imitation, and Comprehension tasks. The Production task was not included in this ordering as total percentage correct for this task was very low (Table 2).

Table 6

Order of Difficulty of the Nonverbal Imitation, Verbal Imitation and Comprehension Tasks. Number of Children Displaying Particular Patterns in Each Age Group

Tasks			Age			
Nonverbal Imitation	Verbal Imitation	Compre-hension	4;3 N=15	5;8 N=15	6;11 N=15	Total N=45
+	+	+	2	1	5	8
+	+	-	4	6	7	17
+	-	-	3	5	3	11
-	-	-	2	0	0	2
+	-	+	2	2	0	4
-	+	+	1	0	0	1
-	+	-	1	0	0	1
-	-	+	0	1	0	1

Note. Patterns above the line in Table 6 are consistent with the overall order of difficulty, and patterns below the line are inconsistent with the overall order of difficulty

+ = Success
- = Failure

The results of only seven children out of 45 contradicted the above order of task difficulty.

Production Task

In the Production task, the adults tested used then, and then, and first to describe order of events (O); at the same time; and both simultaneously simultaneity (S); a long time, and a short time duration (D), and a combination of these terms for the coordinations (OD,SD). These were all correct descriptions of the temporal relations of the events acted out by the experimenter. A few adults (2% of all responses) used and to describe O or S relations and quickly to describe D relations.

In the Production task, the percentages correct for the three age groups were very low (Table 2) and the differences among percentages of correct responses for the three age groups were not significant. However, a detailed analysis of the descriptions revealed interesting differences among the three age groups. These are summarized in Table 7.

Table 7

Categories of Descriptions in the Production Task
Number of Responses in Each Age Group[a]

Response Categories	Age 4;3	5;8	6;11	Total
A	306	336	350	992
B	115	114	102	331
C	12	0	2	14
D	3	23	2	28
E	43	40	54	137
F	11	15	19	45
G	15	20	67	102
Totals	578	615	628	1821

[a]Total number of trials for each age group is 600; however, the total number of responses for each age group does not equal 600 as some error categories were not included (e.g., "I don't know," "two lights") and some responses for OD and SD were included in two categories, e.g., "Pushed the red and the green for a long time" (SD) was included in Category A for the use of and and in Category G for the use of a long time.

A = Use of and for O,S,OD, and SD; e.g., "Pushed the red and the green."
B = No indication of duration in D trials; e.g., "Pushed the red."
C = Use of together for S, in S and SD trials; e.g., "Red, green together."
D = Use of speed terms for duration; e.g., fast, slow in D,OD,SD trials.
E = Use of first, then, and then to indicate order relations in O and OD trials.
F = Use of at the same time for simultaneity relations in S and SD trials.
G = Use of duration terms; e.g., a little while, a long time in D, OD and SD trials.

Note. Categories above the line show incorrect responses and categories below the line show correct responses.

Categories A through D show the kind of errors the children made in describing temporal relations. The most common error made by children in the three age groups was the use of and to describe any temporal relation (O,D,OD,SD), e.g., "Pushed red and green" (Category A). And is a general term and does not describe any unique temporal relation. The second most frequent error was the omission of describing duration relations, e.g., "Red, pushed red" (Category B). Although these two categories of errors (A,B) were frequent among the younger as well as the older group, the other errors (Categories C,D) were more frequent among the younger two groups. 4-year-olds more often than 5-year-olds and 6-year-olds used together a spatial term to describe temporal simultaneity, e.g., "Pushed red and green together" (Category C). 5-year-olds more often than 4-year-olds, and 6-year-olds used speed terms such as fast, and slow to describe duration, e.g., "Pushed the red fast" (Category D). The latter (Categories C,D) is consistent with Piaget's observations that initially children confuse spatial and temporal relations (also E. Clark, 1971; H. Clark, 1973) as well as speed and temporal relations.

The examination of the correct descriptions of O,S,D (Categories E,F,G) showed that the three age groups do not differ in the number of correct responses for O and S, but that the 6-year-olds more often describe duration relations correctly.

Discussion

Knowledge of temporal concepts precedes knowledge of temporal words describing these concepts, and these two types of knowledge are acquired in a closely related, overlapping manner. For the conceptual knowledge, children first acquire the individual temporal conponents and later their coordination. Similarly, for verbal knowledge, children first acquire words with the individual components and later words with the coordination of these components. Both the across-subjects and within-subject analyses for the nonverbal, and verbal tasks support this finding. Furthermore, the individual components and words describing them are usually acquired in the same sequence: order first, then simultaneity, and finally duration. A possible reason for not observing a stronger acquisition sequence here might be that the children have already correctly identified the three components. Percentages of correct responses for the three were over 70% for all ages (Table 2). In contrast, work with younger children has shown a consistent order of difficulty for the components (Ames, 1946; E. Clark, 1971; Clancy et al., 1976; Cromer, 1968; Feagans, 1974; Keller-Cohen, 1974).

The across-subjects, and within-subject analyses both showed the same order of difficulty among the four tasks: Nonverbal Imitation the easiest, then Verbal Imitation, Comprehension, and Production in that order. This order is consistent with three hypotheses of developmental patterns. First, conceptual knowledge generally precedes linguistic knowledge (Beilin, 1975; Bowerman, 1976; E. Clark, 1974; Johnston & Slobin, 1977; Nelson, Benedict, Gruendel & Rescorla, 1978; Slobin, 1966). In acquiring temporal words, children recapitulate the acquisition order they went through in establishing the conceptual knowledge underlying the words.

Second, children are able to imitate words just beyond their comprehension. This suggests that they may learn to use new words through imitation

(Bloom, Hood & Lightbown, 1974; Slobin 1968).

Third, children understand temporal words before they are able to describe temporal relationships (Bloom, 1974; Ferreiro, 1971; Huttenlocher, 1974). Analysis of the Production task showed that the children in the three age groups did not usually describe the temporal relations of events correctly; they either omitted describing them, or used inappropriate terms, e.g. spatial or speed terms. One may argue that the children failed to describe the temporal relations because they did not even perceive them. However, the children's superior performance on the Nonverbal Imitation task suggests that the children knew the temporal relations conceptually but did not use the appropriate temporal words to describe them.

It should be noted that the Nonverbal Imitation task tests only a certain level of conceptual knowledge. It is an earlier form of representation than the corresponding spontaneous actions. Children's imitation is an active process of assimilating and reorganizing the adult model and reproducing it in accord with their current conceptual competence (Piaget, 1951). Verbal imitation plays a similar role in the development of linguistic competence (Bloom et al., 1974).

In this study, the acquisition of temporal concepts and temporal words was examined with a cross-sectional design instead of a longitudinal design. Nevertheless, the evidence provided for the Temporal Complexity Hypothesis (O,S,D before OD,SD), and the sequence predicted by the Temporal Complexity Hypothesis was observed in all four tasks. Furthermore, within each task the experimental demands were the same for O,S,D,OD,SD so the results reflect differences among the concepts rather than among the tasks.[2]

The within-subject analysis of the data supported the conclusions of the across-subjects analysis. First, for the Temporal Complexity Hypothesis, the hypothesized order of acquisition was consistent for most children, since only a few reversals occurred. Second, of the children who succeeded on O,S, and D a minority of the younger children but a majority of the older children also succeeded on OD,SD. Thus, the order of difficulty established with the across-subjects analysis reflects an order of acquisition: O,S,D are acquired before OD,SD. Similarly, the within-subject analysis of the tasks verified the order of difficulty of the tasks suggested by the across-subjects analysis.

Do OD,SD start developing only after O,S,D have reached their final developmental point, or do O,S,D and OD,SD overlap in their development? The results support the latter alternative. O,S, and D appear to continue improving after OD,SD start developing. Improvement across ages for O,S,D was significant (Table 2). The results of the order of difficulty among the tasks suggests that the improvement is in understanding the concepts O,S,D, OD,SD first, and then in mastering the temporal words describing these concepts. The course of development of the concepts and words also overlap with each other. A reason for the latter is that a word can be attached to

[2]The multi-concept, multi-task correlation matrix shows that heteroconcept correlations were low, discriminant validity for the components and coordinations was good (Kayra-Stuart, 1978).

a concept at any point in the process of concept development rather than only to concepts already acquired. Consequently, when children first understand or use a word, it may not have the full adult meaning, e.g. while, during, until in this study were interpreted to mean order or simultaneity instead of simultaneity + duration or order + duration. A second reason is that the language does not provide a one-to-one mapping between concepts and words, e.g., when can be interpreted to mean order or simultaneity, and before, after, first, last, all describe order. The precise nature of the semantic complexity of these words needs to be further studied.

The finding that the components O,S,D are acquired before their coordinations OD,SD contradicts Piaget's proposal that O,S,D relations are not mastered until they are coordinated with each other. Piaget contends that the concept of time is acquired all at once when O,S,D are integrated into one system (1927). Here it is proposed that the concept of time is acquired in stages, first the components are acquired individually, and then they are integrated into one system.

Piaget's data is not directed to his proposal that O,S,D are acquired and coordinated simultaneously. He normally did not test each component by itself. His tasks asked children to compare two overlapping actions which required the children to coordinate information about order and duration. For example, in one experiment, children observed a race between two figures which started and/or stopped at different times while moving at the same or different speeds (Piaget, 1927, chs. 3,4). The children made correct duration judgments only when they based their judgments on the starting and stopping times of the two figures and not on the speed or distance travelled. For example, to the question, "Which one went for more time?" they responded with, "The red one because it started before the green one and stopped after the green one." In this example, order, and duration are coordinated, i.e., they are processed simultaneously. Whenever children have to compare two overlapping durations, the judgments involve either OD or SD. In this study, duration is tested with the presentation of only one movement. Similarly, order or simultaneity are tested when two movements are presented with their duration kept minimal, and thus disregarded or considered instantaneous.

Piaget's data which does provide information about the acquisition of the isolated components does not support his proposal. Piaget and researchers who later replicated his experiments found that order was acquired prior to the integration of O,S,D (Levin, 1977; Levin, Israeli & Darom, 1978; Lovell & Slater, 1960; Piaget, 1927).

The Complexity Hypothesis (H. Clark, 1973) predicts the acquisition of the components before their coordinations. According to this hypothesis, if the structure of A is entirely contained within the structure of B, then A should be acquired first. In this study, each component (O,S,D) is contained entirely within its coordination (OD,SD). Consequently, the individual components and words with one component should be acquired first. A strategy observed by Piaget (1971) also suggests why the components are acquired before their coordinations. According to Piaget, children tend to focus their attention on one component of an event to the exclusion of others. The substitution errors in the current study support this in that children gave O,S, D responses to OD,SD items. They focused only on one component of the

coordination instead of processing both components. Also, in the Comprehension and Verbal Imitation tasks while, during, and until describing a coordination of two components (SD,OD) were interpreted to mean only one component (O,S) (Semantic Feature Hypothesis, E. Clark, 1973).

The consistency of the results across the four tasks suggest that O,S, D are valid components for studying the acquisition of temporal concepts, and temporal words. The definition of temporal words in terms of the components and their coordinations correctly predicts the order of acquisition of these temporal words (see also Feagans, 1974; Keller-Cohen, 1974). Componential analysis of concepts and words should prove useful in further work comparing the acquisition of the related concepts of space, time, and speed and the words describing these concepts.

References

Ames, L.B. The development of the sense of time in the young child. Journal of Genetic Psychology, 1946, 68, 97-125.

Barrie-Blackley, S. Six-year-old children's understanding of sentences adjoined with time adverbs. Journal of Psycholinguistic Research, 1973, 2, 153-165.

Beilin, H. Studies in the cognitive basis of language development. New York: Academic Press, 1975.

Bloom, L. Talking, understanding and thinking. In R.L. Schiefelbusch and L.L. Lloyd (Eds.), Language perspectives - acquisition, retardation, and intervention. Baltimore: University Park Press, 1974, pp. 285-312.

Bloom, L., Hood, L., & Lightbown, P. Imitation in language development: if, when, and why. Cognitive Psychology, 1974, 6, 380-420.

Bowerman, M. Semantic factors in the acquisition of rules for word use and sentence construction. In D. Morehead and A. Morehead (Eds.), Directions in Normal and Deficient Language. Baltimore: University Park Press, 1976.

Clancy, P., Jacobsen, T., & Silva, M. The acquisition of conjunction: A cross-linguistic study. Papers and Reports on Child Language Development, 1976, 12, 71-80.

Clark, E.V. Some aspects of the conceptual basis for first language acquisition. In R.L. Schiefelbusch & L.L. Lloyd (Eds.), Language perspectives: acquisition, retardation, and intervention. Baltimore: University Park Press, 1974, 105-128.

Clark, E.V. On the acquisition of the meaning of before and after. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 266-275.

Clark, E.V. Language acquisition: The child's spontaneous description of events in time. Unpublished doctoral dissertation, University of Edinburgh, 1969.

Clark, H.H. Space, time, semantics and the child. In T.E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973.

Cromer, R. The development of temporal reference during the acquisition of language. Unpublished doctoral dissertation, Harvard University, 1968.

Feagans, L. Children's comprehension of some temporal and spatial structures. M.C. La Gayl, R.A. Box, & A. Bruch (Eds.), Papers from the 10th regional meeting, Chicago Linguistic Society, 1974.

Ferreiro, E. Les relations temporelles dans le langage de l'enfant. Geneva: Droz, 1971.

Finn, J.D. A general model for multivariate analysis. New York: Holt, Rinehart and Winston, 1974.

Fraisse, P. The psychology of time. New York: Harper and Row, 1963.

Howes, D.A. A word count of spoken English. Journal of Verbal Learning and Verbal Behavior, 1969, 5, 572-604.

Huttenlocher, J. The origins of language comprehension. In R.L Solso (Ed.), Theories of cognitive psychology: The Loyola symposium New York: John Wiley & Sons, 1974

Johnston, J.R. & Slobin, D.I. The development of locative expressions in English, Italian, Serbo-Croatian, and Turkish. Papers and Reports on Child Language Development, 1977, 13, 134-147.

Kayra-Stuart, F. The development of the concept of time in terms of the components of order, simultaneity, and duration. Unpublished doctoral dissertation, Claremont Graduate School, 1978. Dissertation Abstracts International, 39(6), Order No 7823839.

Keller-Cohen, D. The acquisition of temporal reference in preschool children. Unpublished doctoral dissertation, State University of New York at Buffalo, 1974.

Levin, I. The development of time concepts in young children: Reasoning about duration. Child Development, 1977, 48, 435-444.

Levin, I., Israeli, E., & Darom, E The development of time concepts in young children: relations between duration and succession. Child Development, 1978, 9, 755-764

Lovell, K., & Slater, A. The growth of the concept of time: A comparative study. Child Psychology and Psychiatry, 1960, 1, 179-190.

Nelson, K., Rescorla, L., Gruendel, J. & Benedict, H. Early lexicons: what do they mean? Child Development, 1978, 49, 960-968.

Piaget, J. Le development de la notion de temps chez l'enfant. Paris: Presses Universitaires, France, 1927.

Piaget, J. Biology and Knowledge. Chicago: University of Chicago Press, 1971.

Piaget, J. Play, dreams and imitation in childhood. Translated by C. Gattengo & F.M. Hodgson. New York: Norton, 1951.

Slobin, D.I. Comments on McNeill's 'Developmental Psycholinguistics' In F. Smith and G.A. Miller (Eds.). The genesis of language: A psycholinguistic approach. Cambridge: M.I.T. Press, 1966.

Slobin, D.I. Imitation and grammatical development in children. In N.S. Endler, L.R. Boulter, & H. Osser (Eds.), Contemporary issues in developmental psychology. New York: Holt, Rinehart, and Winston, 1968.